

# PATENT SPECIFICATION

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## DRAWINGS ATTACHED

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## (54) INDUSTRIAL TRUCKS

(71) We, CONVEYANCER LIMITED, a British Company, of P.O. Box No. 24, Thornton Road, Liverpool Road, Warrington, WA5 1QT, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to industrial trucks of the battery electric type.

Battery electric trucks, particularly lift trucks, are limited in their working day by the battery capacity which can be provided and in many cases where there is an arduous work cycle it is necessary to change the battery in order to keep the truck working through the day or shift. This and attendant disadvantages are overcome by our invention.

According to the present invention there is provided a battery electric industrial truck including an electricity generating set comprising at least one alternator with output rectifier means and an internal combustion engine, the generating set being drivable by an internal combustion engine to charge the battery of the truck while the truck is in use.

In order that the invention may be more fully understood, several embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 shows a power supply arrangement for a standard lift truck comprising one alternator,

Figure 2 shows an alternative power supply arrangement comprising two alternators, and

Figure 3 shows a further alternative power supply arrangement comprising three alternators.

Referring to Figure 1, the normal battery of the standard lift truck is a 36 volt battery of 480 ampere hour capacity. This battery was replaced by a 36 volt battery 1 of 216 ampere hour capacity and the space made available was utilised to accommodate an electricity generating set and its fuel supply. Additional balance weight was added to maintain the rated load capacity of the truck. The generating set

comprises a single cylinder self-driven fan air cooled 4 stroke petrol engine 2 drivably coupled by a belt and pulleys to an alternator 3. The engine has a constant speed governor and an electric starter 4 is provided controlled by a switch 5.

An output regulator 6 for the alternator is also provided and the output is fed through a rectifier 7 to the battery.

At the beginning of the working day the truck operator starts up the generator set, the starter switch 5 for which may be incorporated in the key switch of the truck, and maintains the generator running through the working day. Thus the generator set is sized to supply at least the average energy requirement spread over the working day. The battery provides a reservoir of energy to meet demands in excess of the alternator output and when demands is less than the alternator output energy is put into the battery to restore it to fully charged condition.

The engine exhaust can be substantially free of noxious substances if liquified petroleum gas is used as the fuel and consequently warehouse operation presents no problem. An engine exhaust purifier may be used if desired. A petrol engine or a diesel engine can be used according to requirements.

Where a suitable alternator is not readily available commercially the engine may be arranged to drive more than one alternator. Such an arrangement is shown in Figure 2. A 36 volt system is provided as before, but a 12 volt (nominal) and a 24 volt (nominal) alternator 10 and 11 have their respective outputs fed individually to the appropriate groups of cells in the battery. The alternators are driven from an internal combustion engine 12 via a belt system 13 and the alternators are provided with regulators 14 and 15 and rectifiers (not shown).

For a 72 volt system three 24 volt (nominal) alternators or two 36 (nominal) alternators might be used, drivably connected so that the 3 phases of one alternator are synchronised with the 3 phases of the other alternator(s) and the outputs from one alternator are con-



5 nected in series with the corresponding outputs from the next alternator so that the output voltage is the sum of the voltage outputs of the individual alternators. With this latter arrangement a single regulator and a single rectifier can be used to control and rectify the output from all the alternators. 65

10 The arrangement of three 24 volt (nominal) alternators is shown in Figure 3. They are driven from a single engine 20 through a toothed belt 21. Rectifiers are provided for each of the three alternators, but a single regulator 22 is provided. 70

15 A truck such as has been described is now independent of a fixed charging station. A fully charged spare battery (for double shift working or for an arduous duty cycle) is not required and the performance of the truck is maintained and even enhanced, since the alternator maintains the battery voltage throughout the working day. Furthermore the truck is less sensitive to inefficiencies of system and rolling resistance because the duty cycle is no longer limited by the initial charge on the battery. 75

20 Consequently expensive items of equipment which are increasingly being fitted to trucks to enhance systems efficiency and so prolong the duty cycle are not required, thus cutting the cost of the truck. Its range of use can similarly be extended by, for example, the fitting of pneumatic tyres to the wheels. This is not normally done on conventional trucks because of the increased rolling resistance as compared with solid tyres cuts down the duty cycle. 80

25 Provision may be made for the generator set to be left running while the truck is not in use so as to bring the battery up to a fully charged state. Automatic stopping of the generator set could be provided by a suitable timing device such as a switch in the ignition circuit. Alternatively a battery condition detector could be varied to cause the generator set to be stopped when the battery is fully charged. 85

30 Where the truck is to be used, for example, in food warehouses and it is essential there should be no atmospheric pollution, arrangements may be made to stop the engine of the generator set automatically as the truck enters the warehouses and restart it again on exit from the warehouse. 90

35 This might be done by a radio transmitter in the doorway whose signals are picked up by a receiver on the truck and the receiver is adapted to operate a relay which, for example, interrupts the ignition circuit or the fuel supply of the engine. Similarly a further receiver may be arranged to operate a relay to energise the engine starter motor to start up the set again when the truck leaves the warehouse. 95

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WHAT WE CLAIM IS:—

1. A battery electric industrial truck including an electricity generating set comprising at least one alternator with output rectifier means and an internal combustion engine, the generating set being drivable by the internal combustion engine to charge the battery of the truck while the truck is in use. 100

2. A truck as claimed in claim 1, wherein the generator set comprises two alternators whose outputs are adapted to be connected through respective output rectifier means to appropriate groups of cells of the truck battery. 105

3. A truck as claimed in claim 1 wherein the generator set comprises three 3-phase alternators which are drivably connected so that corresponding respective phases of the alternators are synchronised, the outputs of the alternators being connected in series. 110

4. A truck as claimed in any preceding claim, wherein the internal combustion engine is a single cylinder self-driven fan air cooled 4 stroke petrol engine. 115

5. A truck as claimed in any of claims 1 to 3, wherein the engine is adapted to operate on liquified petroleum gas. 120

6. A truck as claimed in any of claims 1 to 3, wherein the engine is a diesel engine. 125

7. A truck as claimed in any preceding claim, wherein the engine has an exhaust purifier. 130

8. A truck as claimed in any preceding claim, wherein the internal combustion engine has a constant speed governor. 135

9. A truck as claimed in any preceding claim, wherein the electric starter is provided for the engine and a control switch is associated with the starter. 140

10. A truck as claimed in any preceding claim, wherein the internal combustion engine is drivably connected to the or each alternator via one or more belts. 145

11. A truck as claimed in any preceding claim, wherein means are provided for rendering the generator set operative when the truck is not in use. 150

12. A truck as claimed in claim 11, wherein the timing device is provided for automatically stopping the generator set when the battery is fully charged. 155

13. A truck as claimed in claim 12, wherein the timing device comprises a switch in the ignition circuit. 160

14. A truck as claimed in any of claims 1 to 11, wherein the battery condition detector is provided operative to switch off the generator set when the battery is fully charged. 165

15. A truck as claimed in any preceding claim including a radio receiver for receiving signals and feeding them to a device for switching off the engine. 170

16. A battery electric industrial truck substantially as hereinbefore described with reference to Figure 1, 2 or 3 of the accompanying drawings. 175

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1312699 COMPLETE SPECIFICATION

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Sheet 1

## Sheet 1

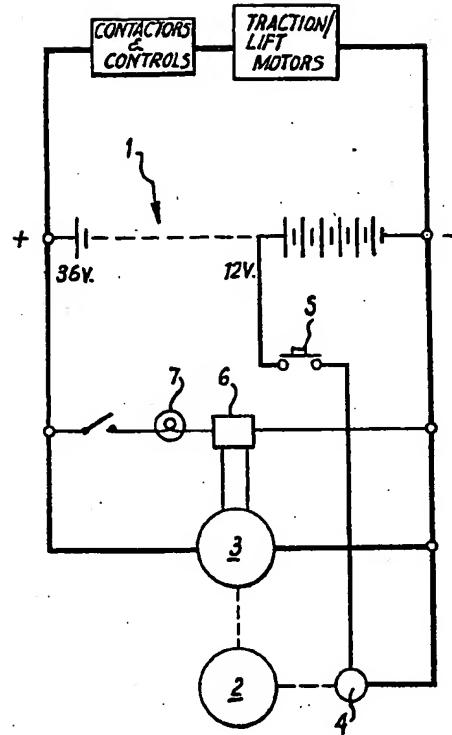


Fig.1

1312699 COMPLETE SPECIFICATION

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Sheet 2

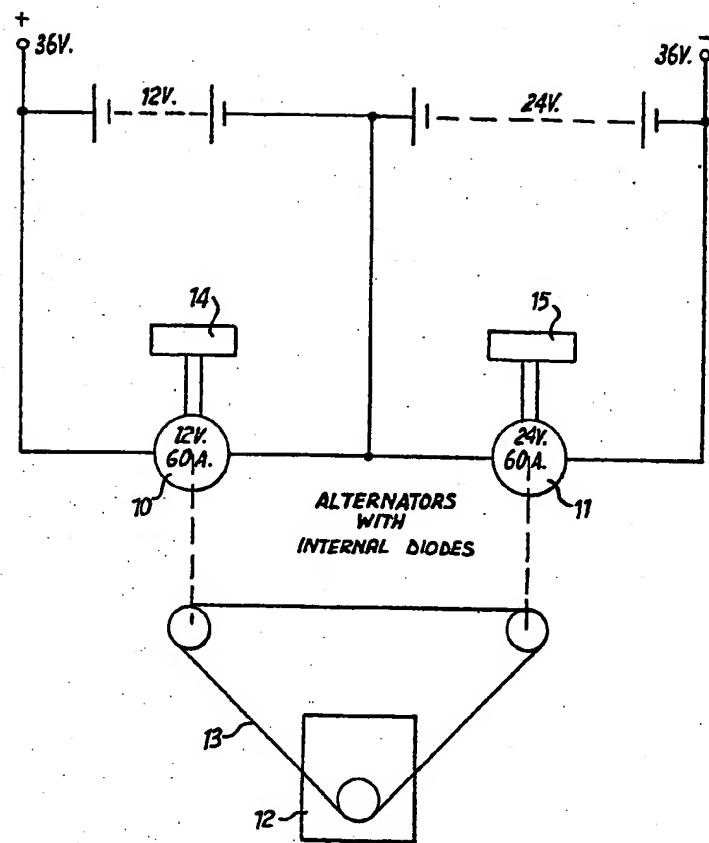


Fig. 2

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COMPLETE SPECIFICATION

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Sheet 3

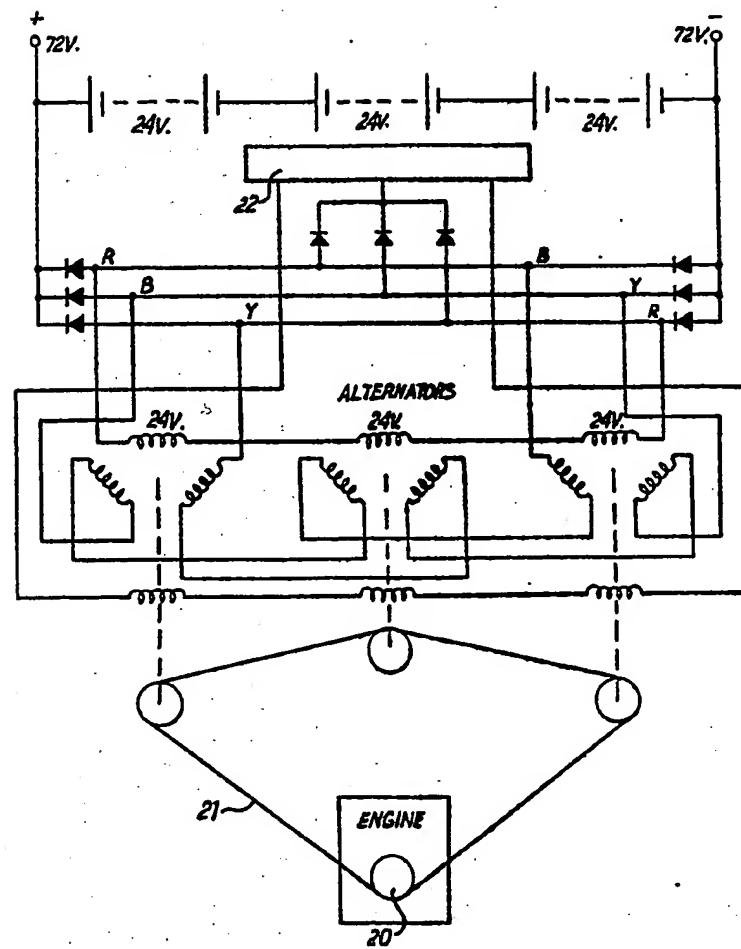


FIG.3